# PROVISIONAL INTELLIGENCE REPORT

# THE PLASTICS INDUSTRY IN THE USSR

CIA/RR PR-77

29 September 1954

DOCUMENT NO. 1
NO CHANGE IN CLASS. ☐
☐ DECLASSIFIED
CLASS. CHANGED TO: TS S C
NEXT REVIEW DATE: 0/1989
AUTH: HR 70-2
DATE: 9-10-79 REVIEWER: 372044

## CENTRAL INTELLIGENCE AGENCY

### OFFICE OF RESEARCH AND REPORTS

**WARNING**

This material contains information affecting the National Defense of the United States within the meaning of the espionage laws, Title 18, USC, Secs. 793 and 794, the transmission or revelation of which in any manner to an unauthorized person is prohibited by law.

PROVISIONAL INTELLIGENCE REPORT

# THE PLASTICS INDUSTRY IN THE USSR

CIA/RR PR-77

(ORR Project 22.168)

NOTICE

The data and conclusions contained in this report do not necessarily represent the final position of ORR and should be regarded as provisional only and subject to revision. Comments and data which may be available to the user are solicited.

CENTRAL INTELLIGENCE AGENCY

Office of Research and Reports

## FOREWORD

This report covers only the basic large-tonnage plastic materials produced in the USSR. The experimental-stage materials which are becoming of increasing importance in the USSR are mentioned where they are significant.

The report does not attempt to cover the fabricated products field. Quantitative estimates of most materials fabricated from plastics would be almost impossible and could contribute little toward estimating the potentialities of fundamental plastic resins in the USSR. Only materials of major military or economic significance are included.

CONTENTS



Appendixes

Page

Tables

# THE PLASTICS INDUSTRY IN THE USSR*

## Summary

The growth of the plastics** industry in the USSR was relatively slow before World War II. After the war, great interest was demonstrated in the development of synthetic chemical plastics. Beginning in 1945, the USSR initiated the expansion and modernization of chemical plants to make way for the production of a greater variety, and a generally more plentiful output, of synthetic plastic resins. German technical personnel -- both prisoners of war and forced-contract scientists -- and reparations machinery were effectively utilized in the expansion of plastics plants. The USSR has succeeded in increasing the output of plastics to a total of 78,400 metric tons*** in 1953.

Although in 1946 the Soviet output of plastics was small compared with the US output, successive yearly increases have brought the Soviet output up to 77,900 tons in 1952, approximately 18 percent of US output.**** This figure may approach the minimum amount sufficient for most military and basic industrial needs. The US produces great quantities of plastics, largely for use in consumer goods. If all production of plastics for other than military and industrial use were trimmed from US production, the remainder would be more closely comparable to Soviet production.

The USSR nevertheless faces difficulty in maintaining its present level of production. Production of plastics in the USSR tends to level off after 1950. As long as the problems of replacing the

* The estimates and conclusions contained in this report represent the best judgment of the responsible analyst as of 1 July 1954.

** The terms plastics and plastic resins are used in this report, which deals only with those types of plastics, to mean molding powders and casting and laminating resins.

*** Throughout this report tonnages are given in metric tons.

**** Figures on US production in 1953 are not available for these resins.

German reparations machinery and technical knowledge remain unsolved, they will continue to hamper further improvement in both quality and quantity of production.

Sixty-six percent of the Soviet output of plastics is in the form of thermosetting* resins (for example, Bakelite). On the other hand, 70 percent or more of the US total output is in the form of thermoplastic resins. Thermoplastic materials, those plastic resins which possess great versatility and adaptability for use in unlimited quantities of consumer items, are in short supply in the USSR. A notable exception appears to be the availability of large supplies of methyl methacrylate, used primarily for aircraft glazing. Soviet production of this plastic in 1953 is estimated to have been at least 14,400 tons, a considerably greater quantity than would seem to be warranted by normal requirements. The general predominance of production of thermosetting materials in the USSR indicates a shortage of modern manufacturing and processing machinery.

Available information about Soviet plastic types does not reveal the existence of certain materials of extreme military or strategic importance. Polyethylene and polytetrafluoroethylene, for example, are urgently needed by the USSR for military electronics and in applications where resistance to extreme conditions of corrosiveness and nigh and low temperature are important. It is believed that the USSR could produce these and other important synthetic resins if the proper machinery were made available through imports from the UK, the US, or West Germany.

Although considerable progress has been made in the Soviet plastics industry, technical advances in both military and industrial science have levied additional requirements. These potential demands exceed the Soviet supply. This conclusion is supported by the annual Soviet requirements placed on the East German plastics industry for ployvinylchloride and other materials. Soviet imports of polyvinylchloride from East Germany were increased from 3,500 tons in 1950 to 8,000 tons in 1953. Polyvinylchloride is of particular importance to both the industry and the domestic economy of the USSR. There are no indications that the USSR has exported any plastic materials.

* See Appendix B for definitions of technical terms.

The major limitation to the continued expansion of the plastics industry in the USSR is the shortage of processing machinery. If this shortage continues, production of plastics is likely to increase slowly.

The plastics industry of the USSR is vulnerable under cold-war conditions to the extent that imports of processing machinery can be proscribed. It appears to be vulnerable to some extent in wartime in that 90 percent of the production facilities are geographically concentrated along the 200-mile railroad line from Moscow to Gor'kiy. The Rulon plant, which produces all the methyl methacrylate for glazing Soviet aircraft, is located in this area.

The Soviet plastics industry might be an indicator of intentions in that any unusually large activity in the production of fluorocarbon plastics, which are used in the preparation of isotopes for nuclear weapons, or in the production of polyethylene, which is used in the manufacture of high-frequency electronics equipment, would suggest more extensive preparation for military activity.

---

## I. Introduction.

### A. General.

During World War II, plastics were used as substitutes for strategic metals in short supply in virtually all industrial countries. As a result of wartime experience, it was found that plastic resins could perform functions completely beyond the realm of metals, rubber, or ceramic materials, and could serve in extreme conditions of heat, cold, and corrosion which no known metallic substances can resist. These plastics are of extreme importance to the development and production of guided missiles and rockets.

This report is designed to answer, insofar as possible, questions relative to the development and strategic importance of the large volume of plastics production, particularly molding powder, casting resins, and laminating resins in the USSR. These materials are significant because they are used in the production of such



Approved For Release 1999/09/02 : CIA-RDP79-01093A000600090003-1

items as proximity fuses, corrosion-resistant linings for chemical reactors, industrial piping, aircraft glazing (blisters), and in certain equipment connected with the extraction of atomic energy materials. This report has been limited to molding powders and casting and laminating resins; the inclusion of other plastics (filaments, adhesives, and protective coatings) would make the study far too broad in scope. The materials discussed in this report fall under the broader categories of thermoplastic and thermosetting resins.

B. Categories.

Plastics are divided into two distinct groups: thermosetting resins and thermoplastic resins. Materials described as thermosetting resins are hard and brittle, as a rule, and may not be reformed with heat or pressure. Thermosetting resins include phenol-formaldehydes, amino-formaldehydes, and polyesters. The first two resins are known to be made in the USSR. The polyesters, largely useful when combined with glass fibers, are not now known to be produced there.

A group of plastic materials having wide usage and showing great promise of future adaptability is the thermoplastic resins, which may be reshaped by the application of heat and/or pressure. Thermoplastic resins include polyvinylchloride, polyvinylacetate, and polymethylmethacrylate.

As pointed out above, the bulk of plastics produced in the USSR is of the thermosetting group.

## II. History and Organization.

The Soviet plastics industry began, as in the US, with the production of phenolic resin (Bakelite) in the mid-1920's. From then until the late 1930's, little development in the plastics industry took place in the USSR. The raw materials required to produce phenolics were obtained from coal tar acids. A minimum of technical effort was required to produce these plastics.

There is little information available on Soviet plastics production during the period between 1941 and 1946. It can be assumed that the entire Soviet effort in plastics was directed during this period toward military needs. Many of the large plants in the

Moscow area were transferred to places of greater safety during the war. This caused serious disruption in productive output.

In the period between 1945 and 1948, the chemical plants involved in plastics manufacture were engaged in a large-scale building program to house a variety of both chemical and plastics production operations. German prisoners of war were forced to repair old factory buildings and aid in the construction of new buildings. While plant reconstruction was in progress, chemical machinery, including equipment for plastics manufacture, was removed from East German plants for reassembly in newly constructed buildings in the USSR.

In several of the Soviet chemical plants, East German scientists, technicians, and engineers were employed on a forced contract basis, to supervise the installation of plastic manufacturing machinery and to help Russian technicians put the equipment on a producing basis.

By 1949 the physical expansion program in the Soviet plastics industry had been largely achieved. Capacities were reached and technical equipment was added slowly and with difficulty. However, some German scientists were retained after 1949 to aid Soviet plastics production. Many of these people were returned to East Germany by 1952 and 1953 for further work in East German chemical plants.

The Soviet plastics industry is under the direction of the Chief Directorate of Plastics, which is a subdivision of the Ministry of the Chemical Industry. Plastics resins are produced in widespread chemical plants located in the Caucasus, Leningrad, or the Urals, and West Siberia (in Economic Regions* V, Ia, VIII, and IX, respectively). Approximately 90 percent of plastic resin production, however, is located in the small area between Moscow and Gor'kiy, in Region VII. As a rule, the types of plastics produced in a given plant depend on the chemicals immediately available in the plant or in the area.

* The term region in this report refers to the economic regions defined and numbered in CIA Map 12048, 9-51 (First Revision 7-52), USSR: Economic Regions.

## III. Production.

The USSR apparently does not produce all of the types of laminating and casting resins and molding powders commonly available in the US and other parts of the world. There is reason to assume, however, that the USSR is extremely interested in developing a complete selection of plastic types and that a great effort is being made to obtain such materials through scientific research, industrial development, and imports from the Satellites.

At present there is no evidence that the following important plastic materials are produced in the USSR:

Polyethylene
Polyvinylbutyral
Polytetrafluoroethylene
Polytrifluorochloroethylene
Epoxide resins
Polyester resins
Polyisobutylene

As this report demonstrates, the USSR is apparently deficient in polyethylene, polyvinylbutyral, and polytetrafluoroethylene. These materials are of great importance to the US military effort and would be of considerable assistance to Soviet military developments. No available intelligence gives any definite indication of the production of these materials in the USSR.

There is evidence, however, that the following plastic materials are being produced in the USSR, but no firm production data on them are available.

Polystyrene
Polyvinylacetate
Cellulose nitrate
Cellulose acetate

There are data on Soviet production of the following plastics:

Polymethylmethacrylate
Polyvinylchloride
Phenolic resins
Aminoplastics

Table 1* gives the estimated production of plastics in the USSR from 1946 through 1953. This table includes all of the known production figures as derived from plant studies, plus estimates based on knowledge of manufacturing machinery, plant size, building size, and plant area. As noted above, these figures represent the production of molding powders and laminating and casting resins. In general, the year 1949 in Table 1 represents the base year from which other figures were derived. It is assumed that, because of limited capacities and lack of additional technical aid and machinery, production in some types of polymers tended to level off after 1949.

Table 1 indicates progress in that the 1953 production of all plastic types (molding powders and laminating and casting resins) considerably increased over 1948. This is evidence of the great emphasis which the USSR has placed on the development of synthetic resinous materials.

Examination of the figures in Table 1 points to an important qualitative aspect of Soviet production. The thermosetting resins (phenolics and aminoplasts) constitute approximately 66 percent of all materials produced in 1953. On the other hand, over 70 percent of US production is of thermoplastic types. In this respect the USSR is limited, because thermoplastics are converted to usable forms at a much faster rate than are the thermosetting group. One specific deviation from this trend may be noted in the case of Plexiglas, a valuable methyl methacrylate thermoplastic resin, which was produced at a rate of 14,400 tons per year from the years 1949-53 inclusive. In producing this material the USSR has equaled or exceeded US production in the postwar period. 1/** Soviet military plane production and the consumer goods program could account for a few hundred tons of this methacrylate resin, but such main end usages do not reasonably explain even as much as one-half of this large figure. By US standards, the cost of producing methyl methacrylate would prohibit its wide use in consumer goods. It may be that the USSR disregards cost considerations. It is also possible that rejection ratios are extremely high. A third possibility is that new uses for methyl methacrylate in aircraft, rockets, or guided missiles have been discovered by Soviet scientists. The unresolved question as to the end usage of this costly plastic

* Table 1 follows on p. 8.

** Footnote references in arabic numerals are to sources listed in Appendix F.

Table 1

Estimated Production of Plastics in the USSR a/
1946-53

Metric Tons

| Types of Plastics | 1946 | 1947 | 1948 | 1949 | 1950 | 1951 | 1952 | 1953 |
|---|---|---|---|---|---|---|---|---|
| Polymethylmethacrylate b/ | N.A. | N.A. | 12,000 | 14,400 | 14,400 | 14,400 | 14,400 | 14,400 |
| Phenolic Resins c/ | N.A. | N.A. | 34,850 | 38,100 | 39,500 | 39,500 | 39,500 | 39,500 |
| Polyvinylchloride d/ | 0 | 0 | 3,000 | 6,000 | 7,000 | 8,000 | 8,500 | 9,000 |
| Aminoplastics e/ | N.A. | N.A. | 4,000 to 8,000 | 8,250 | 11,000 | 12,000 | 12,000 | 12,000 |
| Polystyrene f/ | 0 | 0 | Negligible | Negligible | 500 | 500 | 500 | 500 |
| Polyvinylacetate g/ | 0 | 0 | 200 | 400 | 600 | 800 | 1,000 | 1,000 |
| Cellulose Acetate | N.A. | N.A. | N.A. | N.A. | N.A. | N.A. | N.A. | N.A. |
| Cellulose Nitrate h/ | 1,500 | 1,600 | 1,700 | 1,800 | 1,900 | 2,000 | 2,000 | 2,000 |
| Total | | | 55,750 to 59,750 | 68,950 | 74,900 | 77,200 | 77,900 | 78,400 |

a. The term plastics as used here means molding powders and casting and laminating resins. Documentation and derivation of these figures are in the plant studies in Appendix A. Figures given represent minimum estimates.

b. See Appendix A, Rulon Chemical Plant. Plant capacity was reached in 1949. 1948 production is believed to be just under the 1949 production.

c. See Appendix A. The figures for 1948-53 represent actual plus estimated production from Zavod Stroy, the two Karbolit plants, and the Koshalya plant. For example, the 1952 figure represents an actual reported 26,000 tons from Karbolit (Orekhovo-Zuyevo), 6,000 tons from the Stroy plant, and the remainder is estimated production from the Koshalya and the Kemerovo Karbolit plant.

d. See Appendix A, Zavod Stroy. No production in 1946 and 1947. The 1948-53 figures represent actual and estimated shipments from the Stroy plant. The 1948 figure represents the result of approximately 6 months' operation at Stroy. Production rise after 1949 represents an increase in plant efficiency.

Table 1

Estimated Production of Plastics in the USSR
1946-53
(Continued)

e. See Appendix A, Bauman Chemical Plant. Production for 1948 is known to be appreciable, but the exact amount could not be determined. Production leveled off after 1951, when capacity was attained. Increases shown from 1949-51 resulted from the addition of new machinery.
f. See Appendix A, Bauman Chemical Plant. The 500 tons are estimated on the basis of the number of machines at this plant.
g. See Appendix A, Kirov Rubber Plant. Yearly increases are based upon the increasing deliveries of resin to the adjacent Yerevan polyvinylacetate plant from the Kirov plant.
h. See Appendix A, Okhtenskiy Chemical Plant. Estimate is based upon known prewar production. Gradual increases followed World War II, but because of the undesirable incendiary characteristics of this plastic, the plant was believed to have limited its production.

deserves further examination, both because of its great military importance and its importance in the consumer goods program.

A significant comparison may be made between the plastics production of the US and the USSR, based on the resins discussed in this report. Table 2 indicates the wide gap in volume of production between the two countries.

Table 2

Estimated Production of Plastics
in the US and the USSR
1946-53

Metric Tons

| Year | USSR a/ | US b/ 2/ |
|---|---|---|
| 1946 | N.A. | 197,000 |
| 1947 | N.A. | 228,000 |
| 1948 | 55,750 to 59,750 | 306,000 |
| 1949 | 68,950 | 301,800 |
| 1950 | 74,900 | 445,600 |
| 1951 | 77,200 | 471,600 |
| 1952 | 77,900 | 442,800 |
| 1953 | 78,400 | N.A. |

a. Totals taken from Table 1.
b. Figures based on US consumption totals of the plastics considered in this report.

The Soviet plastics industry has made notable progress in volume of output since World War II. Table 2 shows that during the period between 1946 and 1953 the yearly output was raised from a negligible amount to 78,400 tons in steady, successive, yearly increases. This trend indicates a greater demand for finished items of strategic military interest and the allocation of appreciable quantities for consumer items.

Even though US production is vastly superior, the USSR has increased its output from a small percentage of US production in 1946 to approximately 18 percent in 1952. These gains are quite important, considering the fact that the Soviet military has top priority in the allocations of these materials, whereas the bulk of US production is used in a wide variety of consumer goods items not needed, particularly in wartime. In short, it appears that the USSR is approaching a volume of production which, under its standards, may be considered satisfactory.

However, as was pointed out earlier in this section, nothing has been learned about Soviet production of the vital polyethylene and fluorocarbon polymers which now have extensive military uses. A more accurate appraisal of plastics achievements will be possible when positive information is obtained as to the ability of the USSR to supply itself with these particular types.

## IV. Trade.

To date there is little information which would indicate the existence of trade in plastics between the USSR and other countries. The only exception to this is in the case of East Germany, which exports polyvinylchloride to the USSR. 3/ Polyvinylchloride is used for industrial piping and for the manufacture of raincoats, overshoes, shoe soles, and the like. Table 3* shows the estimated East German exports of polyvinylchloride to the USSR in 1950-54. These figures, which indicate that increasing amounts were being sent, 4/ represent the only reliable information available on shipments for these years.

The figures in Table 3 probably do not represent the full amounts of polyvinylchloride moving from East Germany to the USSR. Polyvinylchloride is listed in trade data under various categories of shipments; this practice has the effect of covering up the amounts actually received by the USSR.

The USSR, as is shown in Table 3, has increased the requirement of polyvinylchloride from East Germany each year. East Germany is expected to supply the USSR its 10,000 tons from the Buna Werke, Schkopau plant in 1954. 5/ This 1954 figure is in line with the evidence of year-to-year increases of shipments from East Germany to the USSR, 1950 through 1953 inclusive.

* Table 3 follows on p. 12.

Table 3

Estimated Exports of Polyvinylchloride from East Germany to the USSR 1950-54

Metric Tons

| Year | Exports |
|---|---|
| 1950 | 3,500 a/ |
| 1951 | 5,065 a/ |
| 1952 | 6,850 a/ |
| 1953 | 8,000 a/ |
| 1954 | 10,000 b/ |

a. Actual shipments. The 1953 figure is composed of reparations and plant profits. 6/
b. Planned shipments. 7/

Piatherm (insulating material made from foamed urea-formaldehyde resin) and polystyrene (general-purpose molding plastic for electrical insulating material and consumer items) also are apparently shipped regularly from the East Zone of Germany to the USSR, but yearly totals of these substances are not available because of the fragmentary nature of the trade information. Such shipments, however, point to shortages of plastic materials in the USSR.

The following conclusions may be drawn regarding Soviet imports of plastics from East Germany:

1. The USSR is short of thermoplastic resins.

2. There has been a limited capacity for processing vinyl resins in the USSR, but this apparently is increasing slowly. It is probable that the USSR does not take an even greater portion of East German plastics because it does not have the necessary plastics fabricating equipment at this time.

## V. Requirements.

There is no quantitative information available on which to base the demand for plastics in the USSR. The use pattern of plastic materials is so diverse that it would be impossible to trace down molding materials inputs to the extremely large number of fabricating installations in the USSR. The accumulated data on finished plastic items would not be sufficiently complete to approximate the total Soviet demand.

Demands for certain plastics materials in the USSR have been consistently in excess of the supply. One indication of this condition is noted in the imports of quantities of polyvinylchloride to the USSR from East Germany. Soviet imports of this plastic have been so great that shortages of it are causing market difficulties in East Germany. 8/.

Thermoplastics as a group represent a relatively small part of the synthetic resinous materials available within the USSR. End items directed to military use and high-priced consumer products (automobiles, television sets, and radios) call for a sizable portion of the total output of Soviet plastics. It is evident that a more voluminous production of versatile thermoplastic resins in the USSR would help greatly in filling the need for low-priced, simple articles in the present consumer goods program. Combs, cheap jewelry, and an endless number of novelty items, as well as many necessities, could be delivered to the Russian population in great volumes if manufacturing facilities for thermoplastics were made available.

There are no Five Year Plan figures available for the plastics materials considered within the scope of this report. There are no planned figures for the plastics industry as a whole.

## VI. Capabilities, Vulnerabilities, and Intentions.

### A. Capabilities.

Continued expansion of the Soviet plastics industry will depend on its ability to produce increased quantities of the raw chemicals used in making molding powders and casting and impregnating resins, and on the availability of processing machinery to change these materials into shapes of value. It is believed that one of the most important Soviet bottlenecks is the shortage of processing machinery (molds, molding machines, presses, and extruders available in the UK, the US, and West Germany) for molding and shaping resinous materials originating in the chemical plants. It is probable that the volume of plastics production in the USSR will increase slowly.

B. Vulnerabilities.

The principal weakness of the Soviet plastics industry is that of shortages of processing machinery. Even though large volumes of resins are made available in the USSR, such materials are useless until molding machines are available to convert these substances into usable shapes. Plastics processing machinery, imported from East Germany after the war as reparations, has aided the rapid Soviet expansion in plastics output. Continued improvement in output will depend entirely on the ability of the USSR to avail itself of replacements for wornout equipment, plus additional new machinery. It is believed, therefore, that large gains in productive output can be achieved only through imports.

A high proportion (approximately 90 percent) of plastic resin production is located on or near the Moscow-Gor'kiy rail line. Plastics production, therefore, would be seriously curtailed with the destruction of the plants in this area.

C. Intentions.

Since World War II, the USSR has realized the great importance of plastic resins and has achieved important gains in volume of production. This progress resulted from plant expansion and technical improvements put into effect before 1950. Soviet appreciation of the value of plastics is indicated in many publications. The USSR can be expected to attempt quantity production of resins having strategic military value, as well as a greater volume of general-purpose thermoplastics for the important consumer goods program.

Increased activity in certain types of plastics may act as an intelligence indicator in estimating Soviet trends toward various military interests or toward the intensified production of consumer end items.

Information showing activity (or increased activity) in the production of fluorocarbon plastics (for example, polytetrafluoroethylene) would indicate great interest in the preparation of and/or separation of isotopes for nuclear military weapons. In the same vein, any new large-scale development or production of polyethylene could be considered an intelligence indicator forecasting a corresponding increase of production in the field of high-frequency electronics equipment (radar and related military gear) for military aviation and other components of the armed forces that use this equipment. On the other hand, if it is found that the USSR is expanding production of thermoplastic materials such as cellulose acetate or polystyrene (general-purpose molding materials), increased effort in the production of consumer end items could logically be expected.

APPENDIX A

## PLANT STUDIES

The plants listed below are known to be actively engaged in the preparation of plastic materials from raw chemicals. Though these plants in some cases convert the polymers into end items, their prime function is to provide materials from which finished forms are made. Those plants whose sole purpose is the fabrication of end items or semifinished forms from manufactured polymers are not considered to be engaged in plastics production as such and are not included in the scope of this report. Plants are listed in approximate order of importance.

1. Rulon Chemical Plant No. 148.

Location. This plant is located approximately 3 to 4 kilometers east of the city of Dzerzhinsk (56°15' N - 43°37' E) just north of the main Moscow-Gor'kiy railroad, in Region VII.

Description. This chemical plant was built in 1939 largely for the production of aniline. The production effort was broadened during World War II to include the preparation of hydrocyanic acid from calcium cyanamide, and methacrylate plastics. 9/ Only the eastern part of the plant was devoted to operations during the war; during that time, production was drastically reduced or stopped, and parts of the plant were moved to the Urals, in Region VIII.

Plexiglas* production started in the fall of 1946 and steadily increased with German technical help. Following World War II, the Russians experienced a number of devastating explosions in the building in which acetone was reacted with other materials to produce methyl methacrylate. 10/ It was only through valuable aid given them by the experienced Germans that the Russians were able to surmount their technical problems. In 1947, a new group of buildings was started in the southwestern part of the plant area and almost finished in 1949. This section was reputedly for the preparation of synthetic gasoline, but it is possible that it could be related to the production of methyl methacrylate resins. 11/

* Trade name for US and German methyl methacrylate resins.

Products. Although there are hints that several chemicals are produced in this plant, the principal output is methyl methacrylate in both the monomer form and in the form of polymerized sheets. 12/ Methyl methacrylate sheets are made by heating liquid monomer between plate glass, spaced according to the thickness of the final cured product desired. 13/ Butylmethacrylate is probably made at Rulon by a method similar to the one used to make methyl methacrylate. 14/ The main purpose of the methyl methacrylate production seems to be that of providing glazing for aircraft, and shock-resistant, glass-laminated windshields. 15/ Though a considerable amount of this material is used for the manufacture of consumer goods (pens, combs, cigarette holders, and the like) at the plant, many sheets of untreated methyl methacrylate were shipped out for processing elsewhere. 16/

The production of methacrylates has steadily increased since the fall of 1946, but because the German technical personnel left this area by 1949 and because capacities were reached and new technical machinery needed, it is believed that little increase in production could have taken place between 1949 and the end of 1953. The production estimates given for the Rulon plant are based on the general rise in production from 1946 to 1949 and a leveling off of production after 1949.

The production rate for 1949, based on actual tonnages reported, was 1,000 to 1,200 tons per month, 17/ or roughly 14,400 tons maximum.* There are no recent indications that production has increased materially beyond the 1949 output. An increase in production would not materially aid the USSR; improved quality control would be a far more important goal.

The Rulon plant produces all known methyl methacrylate for the USSR. It is therefore a key plant for supplying this important plastic material to other fabricating establishments which are engaged in the production of such strategic items as blisters for jet aircraft. Table 4** shows the estimated production of methyl methacrylate in the USSR during 1946-53.

---

* Production could also be calculated using acetone input data on a 300-day per year basis. 18/ This would give a maximum figure of 16,800 tons of methacrylate for 1949. It is believed, however, that actual production is much closer to the 14,400 figure given (see Appendix D, Methodology).

** Table 4 follows on p. 19.

Table 4

Estimated Production
of Methyl Methacrylate in the USSR
1946-53

| | Metric Tons |
|---|---|
| Year | Production |
| 1946 | N.A. |
| 1947 | N.A. |
| 1948 | 12,000 a/ |
| 1949 | 14,400 b/ |
| 1950 | 14,400 c/ |
| 1951 | 14,400 c/ |
| 1952 | 14,400 c/ |
| 1953 | 14,400 c/ |

a. Production believed to be just under 1949. Full production not reached in 1948.
b. Based on actual tonnages reported.
c. Plant operated at capacity after 1949.

2. Zavod Stroy No. 96.

Location. This plant is located approximately 3 to 4 kilometers east of Dzerzhinsk (56°15' N - 43°24' E) immediately south of the main Moscow-Gor'kiy railroad, in Region VII.

Description. Zavod Stroy started production in 1934 or 1935. By 1940 the plant was engaged in the production of a large variety of chemicals, including hydrochloric acid, sodium hydroxide, chlorine, lead-sodium alloy (for the preparation of tetraethyllead), and many other chemicals including poison gases.

Following World War II a large expansion program was started at Zavod Stroy. Great quantities of dismantled German chemical plant machinery arrived by rail at the plant. 19/ The construction of new buildings was started, using German prisoner-of-war labor. These new buildings were equipped with machinery taken by the

Russians from chemical plants in Merseburg and Bitterfeld in the Soviet Zone of Germany. Planning of production in the reassembled plants was supervised by the German scientists and technical personnel who were employed on a forced contract basis. Polyvinylchloride production was started at Zavod Stroy in 1947, with the aid of Bitterfeld technical personnel.

Products.

Polyvinylchloride. Many polymeric materials are undoubtedly produced in this plant. 20/ Polyvinylchloride and phenolic resins are specifically mentioned as being in production. 21/

The 1949 production of polyvinylchloride was reported to be 20 tons per day. 22/ On the basis of a 300-day year, the total production for 1949 was 6,000 tons of polyvinylchloride. Production for 1948, when the plant was in production only 6 months, is estimated at one-half of that for 1949. Estimates of slight increases during 1950-53 are based on improved efficiency.

While this same plant was in Germany it had a yearly productive capacity of 18,000 tons. 23/ It is known, however, that only part of the plant was moved to the USSR, 24/ and it is reasonable to assume that the Soviet rate of production is considerably less than when all of the plant was in Germany. Zavod Stroy is the only known producer of polyvinylchloride in the USSR at this time.

Table 5* shows the estimated production of polyvinylchloride in the USSR during 1948-53.

The Zavod Stroy plant is considered important to the USSR because it has been developing processes for the production of thermoplastic resins. It is possible that it is also producing other plastics of great importance. 25/

Phenol-Formaldehyde Resins. This material is produced at Stroy in the form of molding powder and is shipped from the plant at a rate of two 20-ton rail carloads per day. 26/ Based on the capacity of Soviet 20-ton freight cars (45 cubic meters), an 80-percent loading efficiency, and a probable bulk density of 0.5 grams per cubic centimeter, the 2 cars contain about 36 tons of molding powder. As

* Table 5 follows on p. 21.

Table 5

Estimated Production of
Polyvinylchloride in the USSR
1948-53

Metric Tons

| Year | Production |
|---|---|
| 1948 | 3,000 a/ |
| 1949 | 6,000 b/ |
| 1950 | 7,000 c/ |
| 1951 | 8,000 c/ |
| 1952 | 8,500 c/ |
| 1953 | 9,000 c/ |

a. Estimated as one-half of 1949 production. Plant was in production only 6 months.
b. Computed on the basis of a 300-day year.
c. Estimates based on improved efficiency.

about 48 percent of standard phenolic molding powder weight is wood flour (used as filler for plastic compounds) 27/ and the remaining weight is considered to be resin compound, the actual production of resin per day is estimated at approximately 19 tons. (See Appendix D, Methodology.) On the basis of a 300-day year, the production rate is estimated at 5,600 tons for 1949. Production in 1948 is estimated at approximately two-thirds that of 1949. Plant capacity is believed to have been reached in 1950.

Table 6* gives the estimated production of phenol-formaldehyde resins at Zavod Stroy, 1946-53. These are considered reliable estimates of minimum figures, assuming that the production rate leveled off after 1950.

* Table 6 follows on p. 22.

Table 6

Estimated Production of Phenol-Formaldehyde
Resins at Zavod Stroy No. 96
1946-53

| Year | Metric Tons<br>Production |
|---|---|
| 1946 | N.A. |
| 1947 | N.A. |
| 1948 | 4,000 a/ |
| 1949 | 5,600 b/ |
| 1950 | 6,000 c/ |
| 1951 | 6,000 c/ |
| 1952 | 6,000 c/ |
| 1953 | 6,000 c/ |

a. Plant production in 1948 estimated at approximately two-thirds that of 1950.
b. Calculated on the basis of a 300-day year.
c. Plant capacity believed to have been reached in 1950.

3. Zavod Karbolit Chemical Plant.*

Location. This plant is located in the village of Zuyevo (55°49' N - 39°02' E) near Orekhovo, which is 80 kilometers east of Moscow on the Moscow-Gor'kiy railroad, in Region VII. These two towns are usually referred to compositely as Orekhovo-Zuyevo.

Description. Zavod Karbolit is the largest and oldest chemical plant in the USSR. It was built before 1900 on a site occupying 400,000 square meters and consists of many large buildings. The production of phenolic resins in the USSR was started at Karbolit in the early or mid-1920's. Since that time the plant has become the largest volume producer of plastic materials in the USSR.

* There are two Karbolit plants. The other one, at Kemerovo, is also discussed in this appendix.

Shortly before World War II, Karbolit started the production of appreciable quantities of methacrylate resins. Plastics production at Karbolit was greatly reduced in the latter part of World War II, but was resumed at a high level after 1946.

During World War II, part of this plant was moved, for reasons of safety, to Kemerovo in West Siberia, in Region IX. This plant was also given the name Karbolit.

There was apparently little bomb damage in the Orekhovo-Zuyevo Karbolit during the war; however, a program of renovation and construction was started in 1945. German prisoners of war were employed as construction laborers, modernizing old buildings and constructing new buildings. In late 1948, many new buildings were finished and outfitted with machines. Since 1949 there has been no information on these newer buildings because practically all German prisoners of war were removed, eliminating the main source of information on this plant.

Products.

Phenolic Resins. The production of molding powders accounts for a high percentage of phenolic resins manufactured in this plant. 28/ Considerable quantities of molding powder are used to fabricate ordnance parts in the plant for the Soviet army. The remainder is shipped to fabricating plants. 29/

Since there are no data on the production of phenolics at Karbolit, indirect means must be employed in estimating molding powder production. Wood flour was delivered to the plant at the rate of 78 tons per day and was used as a filler in the preparation of phenolic molding powder. 30/ Using a standard wood-filled phenolic molding compound formulation, 31/ it was estimated that the actual amount of phenol-formaldehyde resin produced in this plant was 72 tons per day. On the basis of a 300-day working year, the plant was estimated to have manufactured 21,600 tons of phenolic resin for the year 1948. The 1949 estimate of 25,000 tons includes 1,750 tons of impregnating resins (estimated to be equal to 1948 production) plus an allowance for a small increase in plant efficiency in the production of phenol-formaldehyde resins. Capacity production is believed to have been reached in 1950.

No figures were available, however, on the actual production of phenolic impregnating resins. On the basis of the machinery apparently available, 32/ it is estimated that an additional 1,750 tons were produced in the plant in 1948. This helped to increase the production of phenolics and accounted for a total of 23,350 tons of phenolic resin in Zavod Karbolit for 1948. Table 7 shows the estimated production of phenolic resins at Zavod Karbolit in 1946-53.

Table 7

Estimated Production of Phenolic Resins at Zavod Karbolit Chemical Plant in the USSR
1946-53

| | Metric Tons |
|---|---|
| Year | Production |
| 1946 | N.A. |
| 1947 | N.A. |
| 1948 | 23,350 a/ |
| 1949 | 25,000 b/ |
| 1950 | 26,000 c/ |
| 1951 | 26,000 c/ |
| 1952 | 26,000 c/ |
| 1953 | 26,000 c/ |

a. Calculated on the basis of wood filler inputs and a 300-day working year at 72 tons per day. (See Appendix D, Methodology.)
b. Includes 1,750 tons of impregnating resins (estimated to be equal to 1948 production) plus an allowance for a small increase in plant efficiency in the production of phenol-formaldehyde resins.
c. Expansion program believed to have had no further effect after 1950.

Methacrylate Resins. In addition to phenolics, the plant is engaged in the molding of methyl methacrylate sheets, which are used principally for the glazing of aircraft. 33/ There is no information available as to the origin of the liquid methyl methacrylate; it is assumed that this material is prepared at the Rulon Plant in Dzerzhinsk and sent to Zavod Karbolit for conversion to solid sheets. This assumption is made because the large quantities of acetone and other starting materials for methacrylates found in Rulon are not present in the Karbolit Plant. On this basis, the methacrylate resin found here will be credited as having originated at Rulon in the monomeric form.

4. Bauman Chemical Plant No. 123.

Location. This plant is located near the southeast part of Moscow in the town of Kuskovo (55°44' N - 37°48' E) in Moscow Oblast, in Region VII.

Description. Aminoplastics were not produced in the plant until the mid-1930's. There was no bomb damage during World War II.

Several of the old dilapidated buildings in the plant were renovated in the early postwar period. New buildings were erected in the northern section of the plant. Some of the more recent constructions were not finished when the German prisoners of war left the area late in 1949.

Products. The resins produced in this plant are aminoplastics, polyvinylchloride, and polystyrene.

Aminoplastics. Though there is no direct production data for this material, the polymer can be clearly identified by distinct phases in the production operation as a urea-formaldehyde resin. 34/ Some of the molding powder prepared from this resin was used in the northern part of the plant for the manufacture of consumer items 35/ such as dishes and combs, but the larger portion was shipped by rail to other plants for molding.

Production for 1948 is known to be appreciable, but the exact amount cannot be determined. The production rate of urea-formaldehyde molding powder can be determined from amounts of the cellulose filler received by the plant. 36/ Based on the known average density of baled cellulose and the volumes of Russian railroad cars, 37/ the weight of cellulose filler input is calculated as being 18.3 tons per day. (See Appendix D, Methodology.) Based on the known weight of cellulose filler employed in this operation, a standard formulation 38/ is used to determine the amounts of resin compound produced in the Bauman plant. The resin indicated by the amount of filler was calculated as 27.5 tons of urea-formaldehyde resin per day. Using a 300-day working year, resin production is calculated to be 8,250 tons for 1949. Increases in 1949-51 resulted from the addition of new machinery. Production is believed to have leveled off after 1951, when capacity is believed to have been reached.

It is assumed that production slowly increased from 1946 through 1951 and leveled off thereafter. Table 8 shows the estimated production of aminoplastics at this plant during 1946-53.

Table 8

Estimated Production of Aminoplastics at Bauman Chemical Plant in the USSR 1946-53

Metric Tons

| Year | Production |
|---|---|
| 1946 | N.A. |
| 1947 | N.A. |
| 1948 | 4,000 to 8,000 |
| 1949 | 8,250 a/ b/ |
| 1950 | 11,000 b/ |
| 1951 | 12,000 b/ |
| 1952 | 12,000 b/ |
| 1953 | 12,000 b/ |

a. Computed on the basis of baled cellulose and filler input, 300 days per year.
b. Increases 1949-51 resulted from addition of new machinery. Capacity estimated to have been attained in 1951.

There is reason to believe that aminoplastics may be produced elsewhere in the USSR. However, information on other plants suspected of producing this material may pertain to molding plants only, rather than to synthesizers of the resin. No positive conclusion on this matter could be reached on the basis of available information.

Polyvinylchloride. In December 1949 a new building was finished and modern machinery was installed for producing polyvinylchloride. 39/ No information is available on the production of this plastic. Two small acetylene generators, which marked the start of the operation, were of experimental size and could not contribute to more than a very small amount of resin production. 40/

Polystyrene. A new building in the northern part of the plant was undoubtedly built for the production of polystyrene starting 1 January 1950. 41/ The same building contained facilities for polymerizing styrene on the first floor and several (approximately 18) extruding machines to make electrical tape on the second floor. The tape was to be used as wrapping for the insulation of cable. 42/ Although styrene was being polymerized here, there was no evidence that monomer was being synthesized. Based on the number of tape machines known to be in the plant, an estimated 500 tons are believed to have been produced each year during 1950-53.

5. Chelyabinsk Plastics Plant K-4.

Location. This plant is located 3.25 kilometers north of the main railway station near Chelyabinsk (55°10' N - 61°25' E) in the Ural Mountains, in Region VIII. 43/

Description. Methyl methacrylate resins have been produced at the Chelyabinsk plant since early in World War II.

Products. Methyl methacrylate sheets appear to be the only material produced in the plant. It is doubtful that monomer is made here; it is probably made in the Rulon Plant in the Dzerzhinsk chemical complex.

6. Koshalya Chemical Plant No. 154.

Location. This plant is located in the northeast section of Vladimir (56°10' N - 40°25' E), about halfway between Moscow and Gor'kiy, on the main Moscow-Gor'kiy railroad, in Region VII.

Description. The plant was founded some time before 1937, at which time the preparation of phenol-formaldehyde resins was started. 44/ At this time, facilities were installed which would allow the processing of vinyl resins. In 1945, scientists were brought from Germany to work in the plant. 45/

Products. There is conclusive proof that phenol-formaldehyde resins are produced and used here as molding powders. 46/ Plastic powdered raw polyvinylchloride resin is brought into the plant after having been synthesized elsewhere and is processed into raincoats and films for other purposes. 47/ Production figures for phenol-formaldehyde at this plant have been estimated on the basis of plant size. Using the size of the Zavod Karbolit (Orekhovo-Zuyevo) plant as the basis (production of 23,350 tons in 1948), the output of the Koshalya plant is computed at roughly one-sixth of the former, or 4,000 tons. Production totals did not change appreciably between 1948 and 1953. This plant was unharmed in World War II.

7. Plastics and Rubber Plant Kirov No. 742.

Location. The plant is located near the Yerevan-Leninkan railroad, 4 kilometers south of the city of Yerevan (40°47' N - 43°50' E) in Armenia, in Region V.

Description. The Kirov plant was developed primarily for the production of carbide and synthetic rubber. It has also been used for the production of rubber tires for vehicles. The equipment for the production of polychloroprene (Neoprene - duPont) was purchased from E.I. duPont in the U.S. In 1948 or 1949, the production of polyvinylacetate was started in this factory. Some of this plastic material was sent to the adjacent, newly constructed, plastics molding plant. 48/

Products. Although carbide, rubber tires, and soveprene synthetic rubber are the principal products of this plant, polyvinylacetate is the only material considered within the scope of this report. Production figures for this plant have been estimated on the basis of plant area and information of annually increasing shipments to an adjacent plastics molding plant. Beginning in 1948, steady increases in production were made through 1952, when production reached an estimated 1,000 tons.

8. Karbolit Chemical Plant (Kemerovo).

Location. The Karbolit plant is located directly southwest of Kemerovo (55°17' N - 86°03' E) in the Kemerovo Oblast in West Siberia, in Region IX. The plant has a spur connection to a branch of the main Trans-Siberian Railroad.

Description. This plant originated in 1943 or 1944 when plant production machinery was transferred from the Karbolit plant in Orekhovo-Zuyevo to this site. In 1945, consumer items were being produced in the plant -- previously only military items, for example, plastic fuses, had been produced. 49/

Products. Molding powders containing phenolic resins are produced here. Some of this material is consumed within the plant to mold finished items. 50/ Production estimates for this plant have been made on the basis of plant area. Capacity is believed to be conservatively estimated at 3,500 tons. This is based on comparative size (with the Orekhovo-Zuyevo plant) as also outlined in the Koshalya plant study. Production was believed to remain approximately the same during 1948-53. No changes were discovered in the operating processes.

9. Okhtenskiy Chemical Plant.

Location. This chemical and explosives plant is spread over a wide area north and northeast of the city of Leningrad. The combine consists of several clusters of factory buildings. The plastics plant is the part of the combine located 3 miles northeast of the rail station in Okhta (58°05' N - 30°29' E) on the east bank of the Okhta River, in Region Ia.

Description. Little is known about the plastics plant. Plastics research, the first in the USSR, was started here in 1924. 51/ Since the plant started, there has been considerable growth both in plant area and in numbers of items produced. In 1933 the plant employed 1,355 workers. 52/

Production. In 1936, 960 tons of cellulose nitrate plastics ("celluloid") were made in this plant. 53/ This firm produces molding powders for plastics and is engaged in making vinyl materials for corrosion-proof pipes and bakelite resins. 54/ Cellulose-derived plastics are probably in production. 55/ Production estimates for cellulose nitrate plastics are based on the known prewar production and a steady increase in production from the end of World War II through 1951. The plant was believed to have limited its production to 2,000 tons because of the limited use of this plastic and because of its incendiary characteristics. This is the only known producer of this plastic in the USSR.

10. Beketovka Chemical Plant No. 91.

Location. This plant is located on the west bank of the Volga River between the railroad track to Stalingrad and the river in the northern part of Beketovka (48°36' N - 44°25' E), in Region VI.

Description. Construction of the original factory buildings was completed in the years 1936 and 1937. 56/ During World War II, machinery and other equipment was removed from the plant to make it safe from the German army. After the war the plant was renovated and enlarged to accommodate machinery brought from East Germany and other occupied countries. A number of new buildings have been erected. 57/

Production. It is believed that polyvinylchloride and polyvinylacetate may be produced in this plant, though there is no concrete evidence to substantiate this. 58/

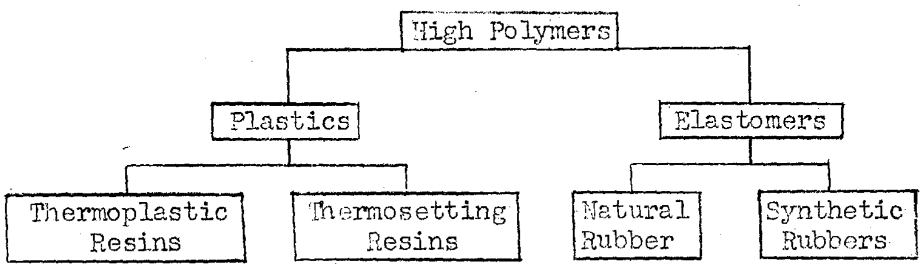
APPENDIX B

## TECHNOLOGY AND GLOSSARY

### 1. Technology.

All plastic materials, no matter where produced, have certain fundamental similarities which must be considered in any study made of the subject. It is felt advisable to show here the relationship between plastics and other high polymers.

Plastics are a subgroup of a broader category referred to as high polymers. The following chart illustrates this point:




High polymers are organic materials composed of supermolecules resulting from the chemical affiliation of the smallest chemical units (molecules) by which a substance may be identified. These minute units, or monomers, are made to interconnect with themselves to form larger units known as supermolecules or high polymers.

Plastics are high polymers, which like elastomers are supermolecules produced through the forced interconnection of smaller molecular or monomeric units. The term elastomer refers to materials composed of supermolecules which have the ability to return quickly to their original shape and dimensions after being deformed under relatively low pressures. Plastics as a rule are firmer and less susceptible to distortion under compression or extension than are elastomers. Plastics do not have the "elastic memory" that is characteristic of elastomers.* Both elastomers and plastics occur in nature in the form of such things as rubber and rosins, and both may be synthesized, or produced synthetically, by the proper combination of simple chemical elements.

The above discussion of high polymers is grossly oversimplified, but will serve as a rough guide to show the position of plastics in relation to other high polymeric materials.

2. Glossary.

The following list is given in order to make the technical terminology used in this report more understandable. These terms have been divided into two general groups: Basic Technological Terms, and Chemical Plastic Names. For greater clarity, items mentioned under the category referred to here as Chemical Plastic Names will also include typical and strategic uses for each material. The list is generally limited to terms and names having a direct bearing on plastics produced or used in the USSR, and those terms which fall within the scope of this report.

a. Basic Technological Terms:

High Polymers. Large molecular aggregates formed by the interconnection of small molecular units. This term usually refers to that general group of chemicals known as plastics and rubbers.

Thermosetting Resins. Plastics which can be molded to a final shape with the aid of heat and pressure but cannot be reshaped, for example, Bakelite (phenolic resin).

* From this discussion it might appear that elastomers and plastic resins are entirely distinct in all respects. This, however, is not the case. A few thermoplastic resins exhibit elastomeric (rubber-like) properties (for example, when heated to 140° to 170° F). Polyethylene, for example, has a tendency to return to its original shape after being distorted under pressure or extension. When polyvinylchloride is thoroughly mixed with certain chemical liquids a rubbery, resilient material is obtained. In spite of the few examples mentioned here, however, plastics and elastomers (rubbers) may be distinguished in terms of the above criteria.

Thermoplastic Resins. Plastic materials which may be shaped and reshaped repeatedly with the aid of heat and pressure, for example, polystyrene, which in the US is now used on a wide scale for consumer items.

Elastomer. A general term that covers both natural and synthetic rubber-like materials.

Elastic Memory. That property of rubber and rubber-like materials which allows these substances to return to an original shape after having been deformed or distorted at a relatively low pressure. High polymers of the plastics group do not exhibit this property.

Monomers. Molecular units particularly intended for the manufacture of high polymers. These units are converted to large aggregates through the formation of chains or random-connected, extremely large molecules. In this manner gases or liquids are converted to solid organic masses; for example, styrene (liquid monomer) may be converted to polystyrene (solid mass).

Polymerization. The chemical interconnection of relatively small molecular units to form large aggregates through the orderly formation of long carbon chains or random-connected matrices.

b. Chemical Plastic Names:

Woodflour. Finely divided particles of wood, usually made from hardwood sawdust (birch or beech). This material is mixed with partially polymerized thermosetting liquid resin. It acts as an extender or cheap filler for the final molded product.

Laminating Resin. Partially polymerized thermosetting resin which is used to enclose and bond fibers or fabric layers into one continuous solid mass.

Molding Powder. Finely divided materials of either thermosetting or thermoplastic groups which may be subjected to heat and pressure to produce solid, continuous forms through the coalescence of individual particles. It is used for the formation of plastic end-products through compression or injection molding.

Polystyrene. A clear, solid plastic material, formed from the polymerization of styrene (a liquid).

Uses: Battery jars, electrical parts, cellular insulation, and general-purpose molding material for innumerable consumer items.

Polyethylene. A milky-white, flexible plastic formed by high-pressure chemical treatment of ethylene (a gas).

Uses: Packing film, jacketing for high-frequency wire and cable, bottles for containing corrosive chemicals, and bottles and stoppers for medicinals and cosmetics and for toys.

Polymethyl Methacrylate. A clear, solid plastic formed by the chemical treatment of methyl methacrylate, a liquid.

Trade names: Lucite (duPont) and Plexiglas (Rohm and Haas).

Uses: Aircraft canopies, dentures, gas mask lenses, and miscellaneous decorative and consumer items.

Polyvinylchloride. A tough, horn-like plastic material made by reacting acetylene and hydrochloric acid. It is known for its important chemical resistant properties.

Uses: Industrial pipe and tubing, cable insulation, lining material for reaction vessels in the chemical industry, and as a general-purpose plastic for consumer items such as raincoats and shoe soles.

Polyvinylbutyral. A soft, flexible plastic made from acetylene, acetic acid, and butyraldehyde.

Use: Principally for the middle layer in safetyglass.

Polyvinylacetate. A clear, general-purpose molding material made from acetylene and acetic acid.

Uses: A variety of consumer items. The Russians find this particularly useful for household and industrial electrical appliances.

Fluorocarbons. Tough, horn-like materials having excellent resistance to chemical action and to deterioration at high temperatures. Generally flexible at very low temperatures. Made by reacting fluorine with ethylene derivatives.

Uses: The USSR uses these valuable materials for aircraft antennae insulators, radar cables, cyclotron boots, distillation tower packing, as lining for nuclear isotope separators, and as a permanent lubrication for a variety of machines.

Phenolics. A hard, resinous substance made by reacting coal-tar acids with formaldehyde. This is one of the most widely used general-purpose plastics in the USSR.

Uses: Bearings, gears, instrument cases, bushings, proximity fuse housings, vacuum tube bases, and for an almost endless list of applications in consumer items.

Aminoplastics. A hard, brittle plastic material, particularly adaptable in molding items requiring decorative appeal as well as abrasive or heat-resisting properties. They are usually made by reacting melamine or urea with formaldehyde. The Russians are known to make this material with urea and formaldehyde.

Uses: Table and counter covers, tableware, and toilet items.

Trade name: Formica.

Polyamides. A tough horn-like plastic having excellent abrasion resistance and an inertness to most petroleum materials. Made from phenol and ammonia.

Uses: Aircraft bullet-sealing; fuel-tank vapor barriers; silent gears; bearings and motor housings, for example, nylon and nylon-like materials when used for molding forms.

Polyesters. A hard resin, valuable in making structural materials when used in conjunction with glass fibers or fabrics. Usually made from organic acids and alcohols. It is not known whether the USSR has developed these products, which are of great strategic value.

Uses: Small boats, radomes, crash helmets, droppable fuel tanks, oxygen bottles, and consumer items such as caskets, cafeteria trays, and trunks.

Epoxides. An almost colorless or amber resin of good electrical insulating properties, usually made by the reaction of bisphenol and epichlorohydrin. This material is particularly valuable because it may be cast-molded into intricate shapes at a relatively low temperature.

Uses: To enclose electronic units (potting resins) so as to protect the components from moisture absorption and damage from shock (of great value for use in such military machinery as guided missiles and rockets).

# APPENDIX C

## MANUFACTURING METHODS

### 1. Methacrylate Resins.*

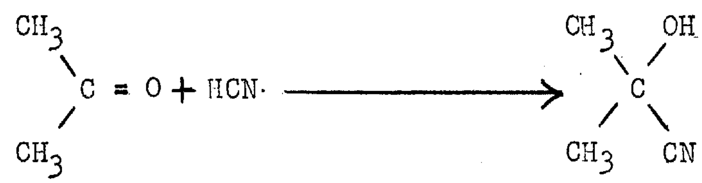
Trade Names: USSR, Orglass; US, Plexiglas (Rohm and Haas) and Lucite (duPont); and Germany, Plexiglas (Rohm and Haas).

This resin is usually made into the form of sheets or rods. It may also be prepared in the form of granules or powder for molding.

The Rulon plant in Dzerzhinsk is the only plant in the USSR known to be producing methyl methacrylate monomer. The plexiglas plants in Orekhovo-Zuyevo and Chelyabinsk polymerize the methacrylate monomer into the form of sheets.

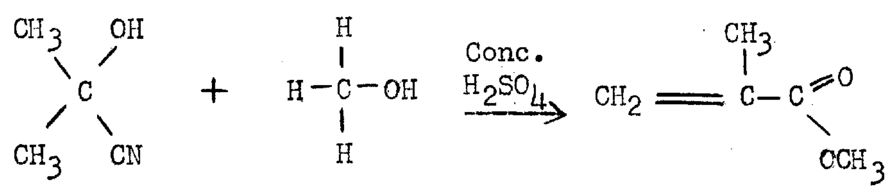
The two following steps describe the chemical route through which methyl methacrylate monomer is made in both the US and the USSR:

A.



Acetone | Hydrocyanic Acid | Acetone cyanohydrin

B.



Acetone cyanohydrin | Methanol | Methyl methacrylate (Monomer)

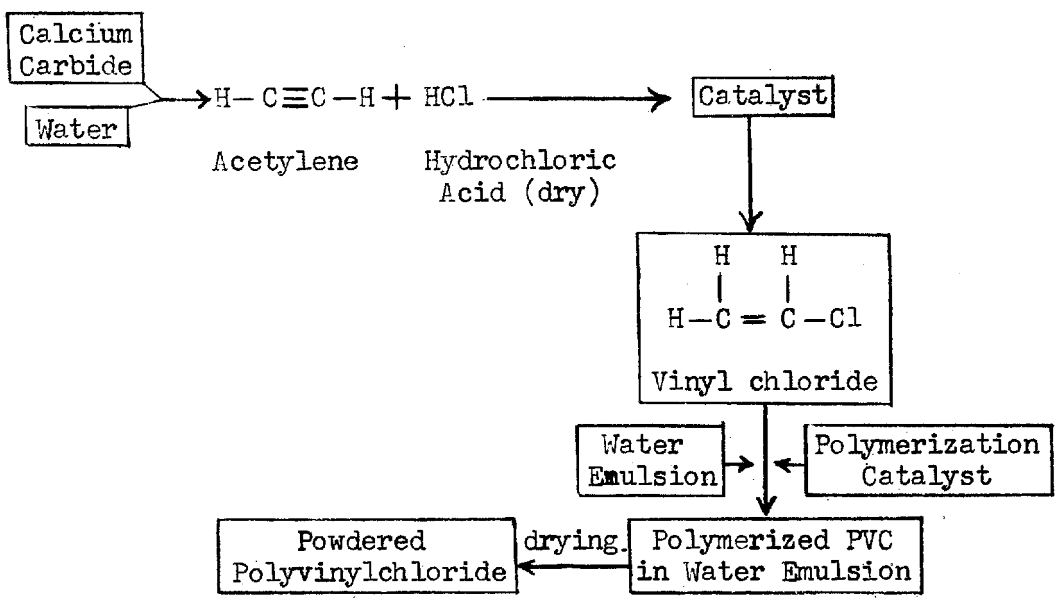
* Referred to in Table 1 as polymethyl methacrylate.

In step (B) of the plant process above, other alcohols may be substituted for methanol. If butanol is used, on the other hand, butylmethacrylate may be prepared. The USSR used the butylester in World War II in the preparation of airplane windshields. 59/ The US has not found this practice desirable. In like manner the use of ethyl alcohol yields ethylmethacrylate. These higher alcohols (ethyl and butyl), for instance, yield polymers which are more pliable than polymethylmethacrylate and which may be molded at lower temperatures. It is possible to use blends of the butyl and ethylmethacrylates to arrive at substances having intermediate hardness and melting points.

2. Polyvinylchloride.

One of the most valuable resins produced in the USSR is polyvinylchloride. Although the production rate is now small compared with US output, large quantities of this material are acquired from East Germany to supplement the Soviet domestic supply.

In 1947, part of the polyvinylchloride plant at Bitterfeld, East Germany, was assembled at the Zavod Stroy Chemical Plant No. 96 near Dzerzhinsk, in Gor'kiy Oblast, in Region VII. 60/ This plant is undoubtedly operated in the same manner as at Bitterfeld. Polyvinylchloride is produced in the following manner at Zavod Stroy:



If electrical grade polymer is desired, additional processing is necessary to remove emulsifying soaps and other materials contributing to poor electrical insulating properties. This purifying procedure is not necessary, however, when the polymer is to be used in industrial corrosion-resistant pipes or in other consumer items not requiring good electrical insulating properties.

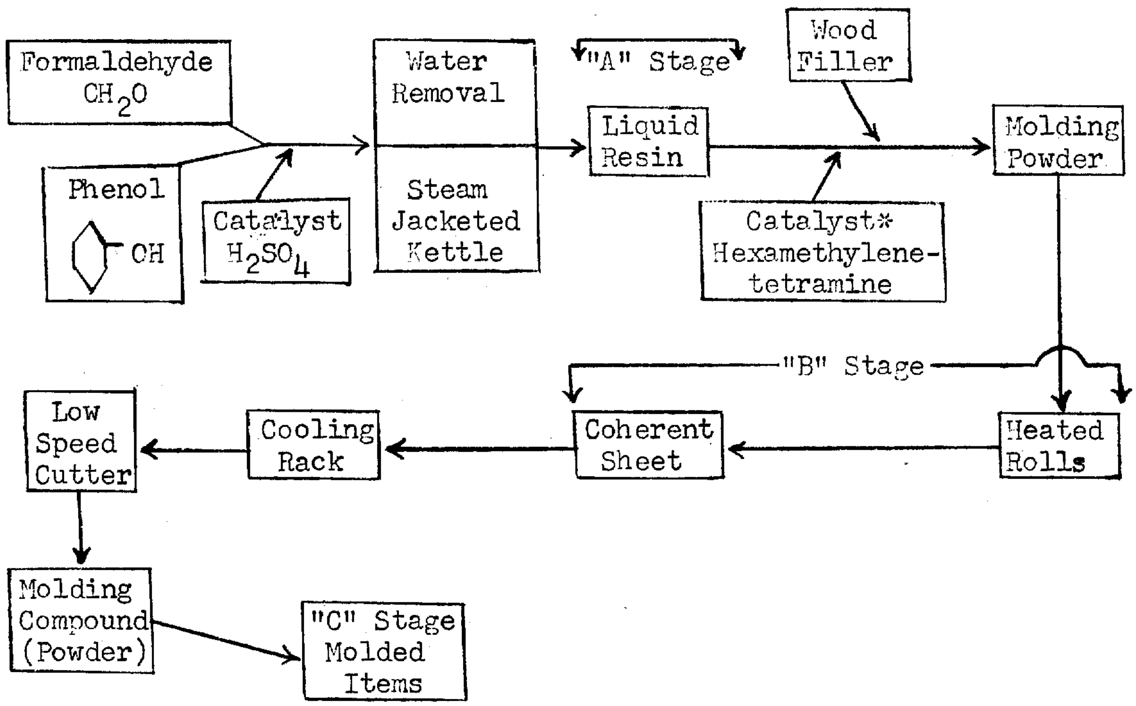
3. Phenol-Formaldehyde Resins.*

The first chemical plastics manufactured in the USSR were those prepared by the reaction of phenol with formaldehyde. The first phenolic resins were produced in the USSR in the mid-1920's, shortly after they were introduced into the US. The original use of phenolic resins was for the preparation of molding powders from which items such as electrical insulators, panels for radios, and electrical instruments were fabricated. These items were compression molded and contained high percentages of cellulose or wood filler to act as extenders and to improve molding and flow properties.

Phenolic molding powder is produced by the Zavod Karbolit Chemical Plant at Orekhovo-Zuyevo, the Karbolit plant at Kemerovo, and the Koshalya and Zavod Stroy plants.

* Referred to in Table 1 as phenolic resins.

The Karbolit Chemical Plant in Orekhovo-Zuyevo is producing large amounts of wood-filled phenolic molding powder, which is produced in the following manner:




The molding compound shown as a final product in the above flow diagram is compression-molded at 300 to 350° F to form finished items (technically in the "C" stage), that is, resins which have been completely polymerized. The "A" stage (liquid) resin may be used to impregnate cotton cloth, dropped fibers, or even glass cloth, or to form sheets, rods, and other shapes by heating the mixtures under pressure. Items made from these moldings possess high rigidity and high impact resistance.

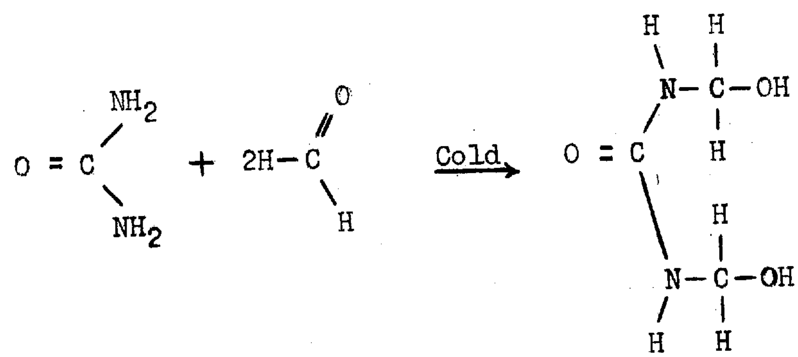
* The use of this catalyst in quantity is an excellent indicator that thermosetting resins are being produced.

4. Aminoplastics.

When urea or melamine is reacted with formaldehyde, light-colored resins are formed which may be compounded with a large variety of fillers, dyes, and pigments. Articles molded from this material are usually pastel in color and have satiny smooth surfaces. These materials are inferior to phenolformaldehyde in acid resistance and in electrical properties but are highly superior to phenolics for decorative purposes, for example, when used in tableware.

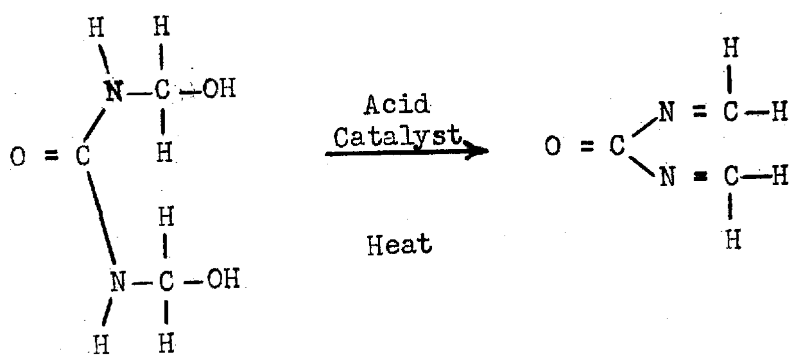
Urea-formaldehyde molding powder is produced in the Bauman Chemical Plant in the following manner:

A.



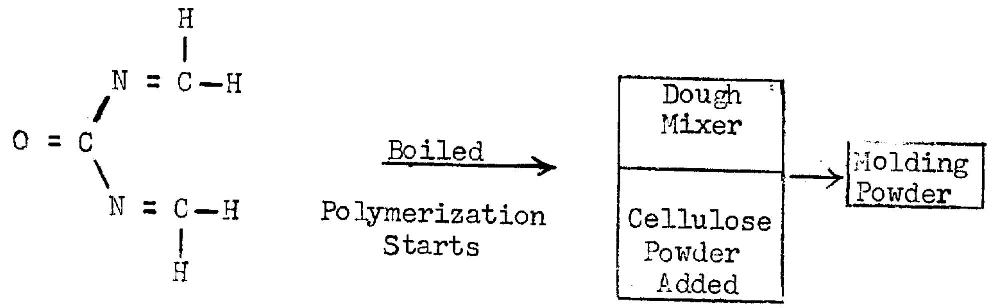

Urea    Formaldehyde    Dimethylol Urea ("A" stage Resin)

B.




Dimethylol Urea    Dimethylene Urea ("B" stage Resin)

C.




Dimethylene Urea

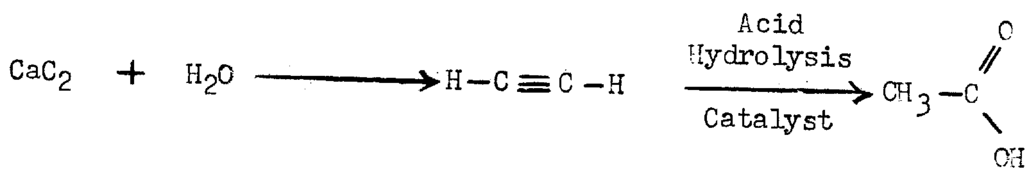
The molding powder is compression-molded at 3,000 to 6,000 pounds per square inch pressure at a temperature of 285° to 315° F to give rigid "C" (final) stage sheets and other articles.

Dimethylene urea (the "B" stage resin) may be used for impregnating textiles or chopped fibers to form table covers.

5. Polyvinylacetate.

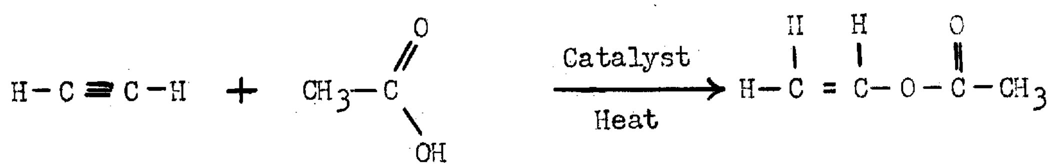
Among the many chemicals produced from calcium carbide in the Kirov plant in Yerevan is polyvinylacetate. Although no information is available on the method of preparing polyvinylacetate in this plant, the following method is probable in view of the large quantities of calcium carbide available there:

A.



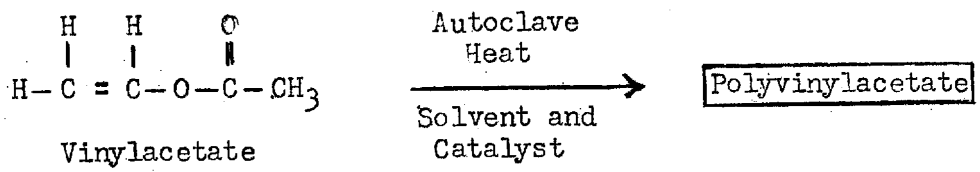

Calcium carbide Water Acetylene Acetic Acid

B.




Acetylene Acetic acid Vinyl acetate

C.




Vinylacetate

It is reasonable to assume that polyvinylbutyral could be produced in this plant using polyvinylacetate as a starting chemical.

## APPENDIX D

## METHODOLOGY

With the exception of the Rulon Plant in the chemical complex at Dzerzhinsk, production outputs for this report had to be obtained by indirection. Reliable information on plastics in the USSR is exceptionally difficult to obtain, as are figures on trade between the USSR and other countries.

Specific information on the derivation of plant production figures is given in the plant studies section. The following summary outlines these procedures on the basis of plastic types:

1. Methyl Methacrylate.

Rulon Chemical Plant No. 148, Dzerzhinsk.

Direct production figures for 1 year were available on methyl methacrylate manufacture at Zavod Rulon, and confirming figures for the same year were also attainable through the use of the daily acetone inputs for the building in which methyl methacrylate monomer was synthesized.

There is no evidence that either Karbolit in Orekhovo-Zuyevo or the plastics factory in Chelyabinsk produced methyl methacrylate monomer. It is believed, therefore, that the production of methacrylate sheets in these plants was entirely dependent on monomer shipments from the Rulon plant.

2. Phenolic Resins.

Zavod Karbolit, Orekhovo-Zuyevo.

Production outputs of phenolic molding powder were obtained through the amounts of wood flour filler intake for the compounding process. A typical compounding recipe 61/ offered a method of arriving at the resin production figure by considering the wood flour intake component as being related to the resin component. Calculations show the phenolic resin production to be 21,600 tons for the year 1948, based on a 300-working-day year.

Zavod Stroy, Dzerzhinsk.

The phenolic resins at Stroy are prepared as molding powder in which wood flour was used as a filler. Two 20-ton freight cars of powder were shipped from the plant each day. In making calculations an 80-percent volume loading capacity for the car 62/ and an apparent density of 0.5 grams per cubic centimeter for the molding powder were considered. It is calculated that 36 tons of powder were shipped from the plant daily. Approximately 48 percent of the weight of a typical phenolic molding powder is wood filler. By subtracting the wood filler weight from the total molding powder output, the resin output for 1949 was estimated at 5,600 tons based again on a 300-working-day year.

3. Aminoplastics.

Bauman Chemical Plant No. 123, Kuskovo.

The production of urea-formaldehyde resin in this plant is determined indirectly through the inputs of cellulose filler incorporated as a component of the molding powder. The volume of cellulose delivered by rail to the plant is known. 63/ By utilizing the usual density of cellulose 64/ delivered by rail, it is calculated that 18.3 tons of cellulose filler were the daily inputs. Using a standard molding powder formula, 65/ the urea-formaldehyde resin may be calculated to be 27.5 tons per day. On the basis of a 300-working-day year, the production of urea-formaldehyde resin for 1949 was 8,250 tons.

The section devoted to production indicates a serious lack of figures in a number of plants which undoubtedly have appreciable outputs. No quantitative data were available to give specific, accurate production figures above a documented total figure of 66,400 tons for Soviet plastics production in the year 1952. Estimates based on relative sizes of factory areas, buildings, and other indications of appreciable production gave figures which raised total Soviet production to a more realistic amount, 77,900 tons for 1952.

Throughout the report a 300-working-day year was used. This figure was decided upon after taking into consideration various factors, including a 7-day work week, power failures, delays in raw material deliveries, and replacement and repair of equipment.

APPENDIX E

## GAPS IN INTELLIGENCE

In the period between 1945 and 1949, the USSR rebuilt and enlarged those chemical plants capable of producing plastics. As most intelligence information came from German prisoners of war engaged in the construction of new buildings in these plants rather than in technical occupations, production data have been only sparingly available. The German prisoners placed in chemical plants were not only poor technical observers in most cases but were so strictly bound by Russian security precautions that they were unable to obtain any more than glimpses of production operations. By late 1948 to 1950, many of the industrial buildings had been finished and German reparations machinery had been installed; in this brief period the war prisoners had a greater opportunity to observe production operations. A few of the German prisoners were assigned to production operations and, in such cases, they had a brief opportunity to observe the manufacture of plastics. The best, and practically the only, figures on plastics produced in the USSR from 1946 through 1953 are those for 1949. In late 1949 and early 1950 the prisoners were sent back to Germany or moved elsewhere in the USSR. This eliminated the greatest source of information on Soviet plastics.

There are not many figures available on Soviet plastics production for the period following 1950 to the present. Furthermore, there is probably little chance of obtaining this information except through chemically trained defectors from the Satellites or the USSR. Figures for 1951, 1952, and 1953 must be estimated on the basis of probable industrial activity.

There is information on part of the production in the following Soviet plants:

| Plant | Location | Product |
|---|---|---|
| Rulon Chemical Plant No. 148 | Dzerzhinsk-Gor'kiy Oblast 56°15' N - 43°37' E | Possible unidentified resin. |

| Plant | Location | Product |
|---|---|---|
| Zavod Stroy Chemical Plant No. 96 | Dzerzhinsk-Gor'kiy Oblast 56°15' N - 43°24' E | Unidentified plastic materials. |
| Zavod Karbolit Chemical Plant | Orekhovo-Zuyevo 55°49' N - 39°48' E | Phenolic impregnating resin. |
| Bauman Chemical Plant No. 123 | Kuskovo-Moscow Oblast 55°44' N - 37°48' E | Unidentified liquid material, polyvinylchloride, polystyrene. |

There are no production data available on the following Soviet plastics plants:

| Plant | Location | Product |
|---|---|---|
| Koshalya Chemical Plant No. 154 | Vladimir 56°10' N - 40°25' E | Phenolic resins and others. |
| Kirov Rubber Plant No. 742 | Yerevan 40°47' N - 43°50' E | Polyvinylacetate and possibly polyvinylbutyral. |
| Karbolit Chemical Plant | Kemerovo (Kemerovo Oblast) 55°17' N - 86°03' E | Phenolic molding powder and impregnating resins. |
| Okhtenskiy Chemical Plant | Leningrad (Okhta Suburb) 58°05' N - 30°29' E | Cellulose esters, celluloid and vinyl compounds. |
| Beketovka Chemical Plant No. 91 | Stalingrad Oblast 48°36' N - 44°25' E | Possibly cellulose acetate and polyvinylchloride. |

There are a number of plastic resin types which should logically be expected to be produced in, or available to, countries considered major military powers, but which are not definitely known to be produced by the USSR. These materials are listed as follows:

1. Polyethylene (for communications equipment)

2. Polyisobutylene (for corrosion resistance materials)

3. Polytetrafluoroethylene (for atomic energy uses and materials requiring high temperature stability)

4. Polytrifluorochlorethylene (for end items which must be flexible at low temperatures)

5. Epoxide Resins (for enclosing delicate electronic units for protection against corrosion and shock)

6. Polyester Resins (for oxygen bottles, small military boats)

7. Polyvinylbutyral (for safety glass interlayer)

It is reasonable to expect that at least small-scale production operations for some of the items listed above is in progress in the USSR. Intelligence data on these items would aid in the measurement of Soviet technological advances in the field of plastics as well as in other scientific fields.

APPENDIX F

## SOURCES AND EVALUATION OF SOURCES

1. Evaluation of Sources.

The economic information available on plastics plants is sparse, and the quality of much of it is poor from an economic intelligence viewpoint. Reports emanating from US defense agencies, [redacted] as a rule give a low priority to economic data on the Soviet plastics industry. For the most part, emphasis is placed on military intelligence requirements which do not call for detailed economic information that could be used in measuring the Soviet plastics industry, especially as it affected the important plastics materials included within the scope of this report.

25X1X709

25X1X7ç

The complex nature of plastics production calls for knowledgeable interrogation in order to extract more significant details and to give a better indication of Soviet developments in this important industry.

A major part of the reports on plastics plants are the result of interrogations of German prisoners of war who had no technical background. Even if these Germans had been scientifically trained, they could not have furnished much information, however, as the Soviet security measures were so harsh that only brief glimpses of production operations were possible.

Unless the plastic is molded or otherwise fabricated in the same plant in which it was synthesized from raw chemicals, there is little chance that the material can be identified as anything more than a "white powder" or an "amber liquid." Partially finished synthetic resins are not only unimpressive to see but are unlikely to attract attention so that they can subsequently be identified. With poison gases and volatile explosive chemicals in these plants attracting the attention of the prisoner-of-war sources, it is understandable that the less glamorous plastic resins are lowermost in the minds of the returned prisoners when interrogated.

The net effect on the data available for analysis of the Soviet plastics industry is evident.

Deficient though they are in data, the many German prisoner-of-war interrogation reports represent the best available sources for study of the Soviet plastics industry. It is reasonable to assume that German scientific personnel returned from work in the USSR have been slow to reveal what they know of Soviet scientific and industrial development because of a continuing fear of reprisal. In the course of research on Soviet plastics, instances have occurred in which returnees from the USSR claimed no knowledge of Soviet plastics operations, although it is positively known that they had a part in advisory and development work in these operations. Further studies of plastics should utilize reports from German scientists who have worked in the USSR.

2. Sources.

Evaluations, following the classification entry and designated "Eval.," have the following significance:

| Source of Information | Information |
|---|---|
| Doc. - Documentary | 1 - Confirmed by other sources |
| A - Completely reliable | 2 - Probably true |
| B - Usually reliable | 3 - Possibly true |
| C - Fairly reliable | 4 - Doubtful |
| D - Not usually reliable | 5 - Probably false |
| E - Not reliable | 6 - Cannot be judged |
| F - Cannot be judged | |

"Documentary" refers to original documents of foreign governments and organizations; copies or translations of such documents by a staff officer; or information extracted from such documents by a staff officer, all of which may carry the field evaluation "Documentary."

Evaluations not otherwise designated are those appearing on the cited document; those designated "RR" are by the author of this report. No "RR" evaluation is given when the author agrees with the evaluation on the cited document.

Next 3 Page(s) In Document Exempt